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April 9, 2015

Mr. Mark Harrell
Livingston Parish Office of Homeland Security
Government Blvd
Livingston, LA 70754

Re: Emergency Response Communication Tower
Intermodulation Study REVISION 1
Project No. 14-073

Dear Mr. Harrell:

We are pleased to submit to you our intermodulation study REVISON results associated with the establishment of a new Emergency Response Communication Tower for Livingston Parish. The original study was issued March 20, 2015. This revision is to add DEMCO and HAM channels to the intermodulation study and supersedes the original report. The study is based upon the information provided, our meetings with your office on November 11, 2014, December 2, 2014, February 27, 2015, March 26, 2015 April 2, 2015 and other documents provided.

We have concluded that, at a minimum, a 650 foot tower should be adequate to house the eight to nine (8-9) tenants as discussed here within.

## I. Project Background:

It is understood that Livingston Parish intends to establish a new communication tower on a currently undeveloped plot of land that is off Hwy. 63 and approximately three-quarters of a mile south of I-12. As understood, the project is being funded by a Community Development Block Grant as provided by the Louisiana Disaster Recovery Unit.

Currently, Livingston Parish utilizes space on a non-parish owned tower for communications. Through this project, Livingston will be constructing a new tower and will relocate some of its radio communications there as identified later within this report.

The tower is planned to be 750 feet in height and will be a guyed structure with wires arrayed at 120 degrees and secured at two radii (6 anchors total). The package for construction is to include the tower, the foundation, the communication equipment building, grid power, back-up power, antennas and communication equipment (repeaters, combiners, narrowers etc.) that are required for a functional system. The existing communication systems, located throughout the Parish will be left as is and used for backup purposes only. We understand that a coordination effort will be required when the new systems are powered up at the new tower requiring the older systems to be brought off line simultaneously.

## II. Importance of The Intermodulation Study:

Following our initial project kickoff meeting of November 11, 2014 we investigated the general parameters of the proposed radio systems that are planned for the tower. This was summarized in a list of frequencies provided to us subsequently by MML&H. Through dialogue with Motorola, it was found that a comprehensive review of the proposed antenna equipment and frequency interoperability had not yet been performed and that two potential restrictions must be addressed. First, the existing radio systems need to be checked for compatibility with the proposed new repeater site. Second, the anticipated configuration of antennas needs to be checked to verify that there is sufficient space at the required heights on a proposed 750' tower to house the systems intended to be relocated.

In our meeting with the LOHSEP and Motorola on December 2, 2014 it was determined that two radio studies were needed. The first theoretical coverage map study would maps that would identify and itemize the existing radio systems authorized for use in the Parish (towers, antennas, repeaters, control points and mobiles) and create theoretical coverage maps by district based on current locations and the potential impacts of relocating those repeaters to the proposed 750' tower. This information would be presented in a map format and shared by the Parish to each candidate for the new tower to provide feedback on any dead zones they may experience within the coverage zone.

The second study, intermodulation, would consider the radio systems selected by the Parish based on theoretical coverage maps and check for interference (1st order, 2nd order & 3rd order "hits" to identify channels that could interfere with each other). The intermodulation study would allow the design to account for appropriate transmitter separation from each other while remaining within the FCC permitted parameters and considering the areas requiring coverage. It is important to keep in mind that raising an antenna height will not necessarily result in better coverage. It is possible that increasing heights could create dead zones closer to the tower than expected and also may not be permitted by the FCC due to the risk of interference to other entities.

At the time the theoretical coverage maps were developed, the Parish had not received feedback from the candidate agencies providing "dead zones" currently being experienced. The results of the theoretical coverage maps are herein this report. These assume that each candidate has full coverage under the theoretical coverage zone. Should any known dead zones be within the limits shown, the results will have to be reevaluated.

With the results of the two radio studies (theoretical coverage maps and intermodulations), we have been able to determine which antennas would benefit from being relocated to the new tower. The remaining antennas would provide better coverage in their existing locations and are therefore excluded from any plans for relocation. With concurrence by Livingston Parish, engineering defined by the original RFP can proceed based on the systems that have been nominated for relocation.

We completed the first intermodulation study and presented our results at your office on March 26, 2015. During our meeting we were requested to include (4) DEMCO channels (which were reduced to (2) channels after discussion with Shawn Parker of DEMCO) and (6) HAM radio channels (which increased to (9) HAM after discussion with Roger Farbe of the GOHSEP). This report includes the summary of both the original intermodulation report and the newly added information received.

Note: Our intermodulation study is based on the anticipation that the FCC will permit the relocation of the LWIN and Parish-wide radio systems to the new tower. The FCC permitting applications will be included under the design contract.

## III. Existing Radio Sites Analyzed:

The design team completed the following tasks in order to create theoretical coverage maps:

1. Review the radio services and frequencies as provided by Livingston Parish and MML&H. See Attachment A.

2. Query the FCC register to identify any known antennas and radio frequencies authorized and licensed for use by the entities noted in the Project Description above. Compare the FCC register to the list provided in Item 1 above to develop an updated composite list. See Attachment B.

3. Create theoretical coverage maps by district based on current locations of repeaters, using the licensed broadcast range as allowed in each FCC permit, along with practical best-case coverage radii given tower height authorized. This information was presented to Livingston Parish February 27 in order to select the candidates for the intermodulation study. See Attachment C.

Attachment A includes two sheets containing the radio systems entity, frequency, call sign, FCC license information, location address, ASR, output power, ERP and antenna height.

Attachment B includes the FCC register including the frequencies, call signs, transmitter address, owner contact and eligibility. The antenna heights and locations were analyzed using this information as this is permitted. During our FCC investigation (documents in attachment A) we discovered discrepancies in the list provided. These discrepancies include location addresses and antenna heights. The register review did not include DEMCO or the HAM channels; DEMO information was provided by DEMCO and HAM radio is an amateur band not regulated by geographical location.

Attachment C includes the theoretical coverage maps which guided the Parish in making their determination on which tenants would move to the new tower. These nominated locations were agreed upon in our meeting was held on February 27, 2015. The maps do not include DEMCO or the HAM channels for the reasons noted above.

## IV. Intermodulation Study

Originally, during the design kickoff meeting held November 13, 2014 a list of possible tenants was provided as follows:

1. Livingston Parish Sheriff Office - 6 channels / Livingston Parish District Fire – 1 channel
2. Office of Emergency Preparedness - 2 channels
3. DSPD - 1 channel
4. DEMCO – may require antenna(s)
5. St. Tammany – microwave to BR
6. Walker PD – may require antenna(s)
7. Livingston Parish District Fire – 1 channel
8. Livingston Parish Council – 1 channel
9. Fire District # 1 - 1 channel
10. Fire District # 2 - 1 channel
11. Fire District # 3 - 1 channel
12. LFD#4 - 1 channel
13. LFD#4 FG1 - 1 channel
14. LFD#4 FG2 - 1 channel
15. LFD#4 FG3 - 1 channel
16. Fire District # 5 - 4 channels
17. Fire District # 6 - 1 channel
18. Fire District # 7 - 1 channel
19. Fire District # 8 - 1 channel
20. Fire District # 9 - 1 channel
21. Fire District # 10 - 2 channels
22. Fire District # 11 - 1 channel
23. School Board – 3 channels
24. LADOTD may require antenna(s)
25. Future expansion for cellular antenna(s)
26. Future growth antenna(s) TBD
27. Future growth for repeater antenna(s)
28. LWIN system (moved from another tower)

Per most recent meetings including guidance received, review of the theoretical coverage maps and guidance provided by your office, the list of tenants on the new tower could include:

1. Office of Emergency Preparedness / Livingston Parish Fire
2. Livingston Parish Sheriff's Office
3. Livingston Parish Fire Districts #4 (2 channels only)
4. Livingston Parish Fire Districts #7
5. Livingston Parish Fire (dispatch)
6. Livingston Parish Council
7. LWIN system (moved from another tower)
8. St. Tammany Parish/BR Microwave
9. Livingston School Board (to be considered in design but not constructed in the bid package)
10. DEMCO (2 channels only)
11. HAM (9 channels only; 3 repeaters, 2 packet and 4 links)

There will also be accommodations for future antennas that will need to be defined shortly for structural design purposed only. The future antennas could not be analyzed as the frequencies are unknown and are yet to be permitted by the FCC.

## V. Conclusion

Based on our findings, it is our opinion that the eight (8) tenants can be housed on a minimum 650 foot tower (located off Hwy. 63 and approximately three-quarters of a mile south of I-12) and have adequate separation (vertical distance) from each other antennas with the use of three transmit combiners, separated transmitters for Fire Districts #4 and #7, and a Receiver Preselect filter of 455-470MHz to avoid the possibility of intermodulation-related "cross talking" on the new tower.

The following are recommended to be placed on the tower:

| No. | Client Name |
|---|---|
| 1. | Office of Emergency Preparedness / Livingston Parish Fire |
| 2. | Livingston Parish Sheriff's Office |
| 3. | Livingston Parish Fire District #4 |
| 4. | Livingston Parish Fire District #7 |
| 5. | Livingston Parish Council |
| 6. | LWIN system |
| 7. | St. Tammany Parish/BR Microwave |
| 8. | DEMCO (2 channels only) |

Pertaining to the HAM additions, we do not believe it is feasible to include (4) HAM link channels due to the proximity of transmit (TX) and receive (RX) antennas. The remaining channels (3 repeater and 2 packet) may be possible to include but consideration must be given to the following:

1. Cost of adding a separate VHF TX combiner, heliax and antenna;
2. Cost of adding a separate VHF RX antenna, heliax and preselector;
3. Vertical separation requirements on tower could require a taller tower;
4. Cost of integrating a separate pass-band into the baseline recommended UHF Preselector (changing from a single passband of 456-470MHz to a dual passband of 445-450 + 456-470MHz);
5. Additional Risk of externally mixed RX hits to Parish frequencies OEP/PF1, OEP/PF2, LPSO2 and LPSO4 caused by (3) HAM repeaters and Packet Channel 2;
6. Risk of the HAM channels interfering with themselves when collocated with Parish channels; and
7. The db420 TX/RX antennas are not designed for 442-446MHz and would produce a higher VSWR at the HAM frequencies under consideration.

Outputs from the intermodulation study can be found under Attachment D. Attachment D contains the associated transmit and receive frequencies of the list above, the proposed grouping, antenna heights and complications resolved during the combining/separation processes.

* **

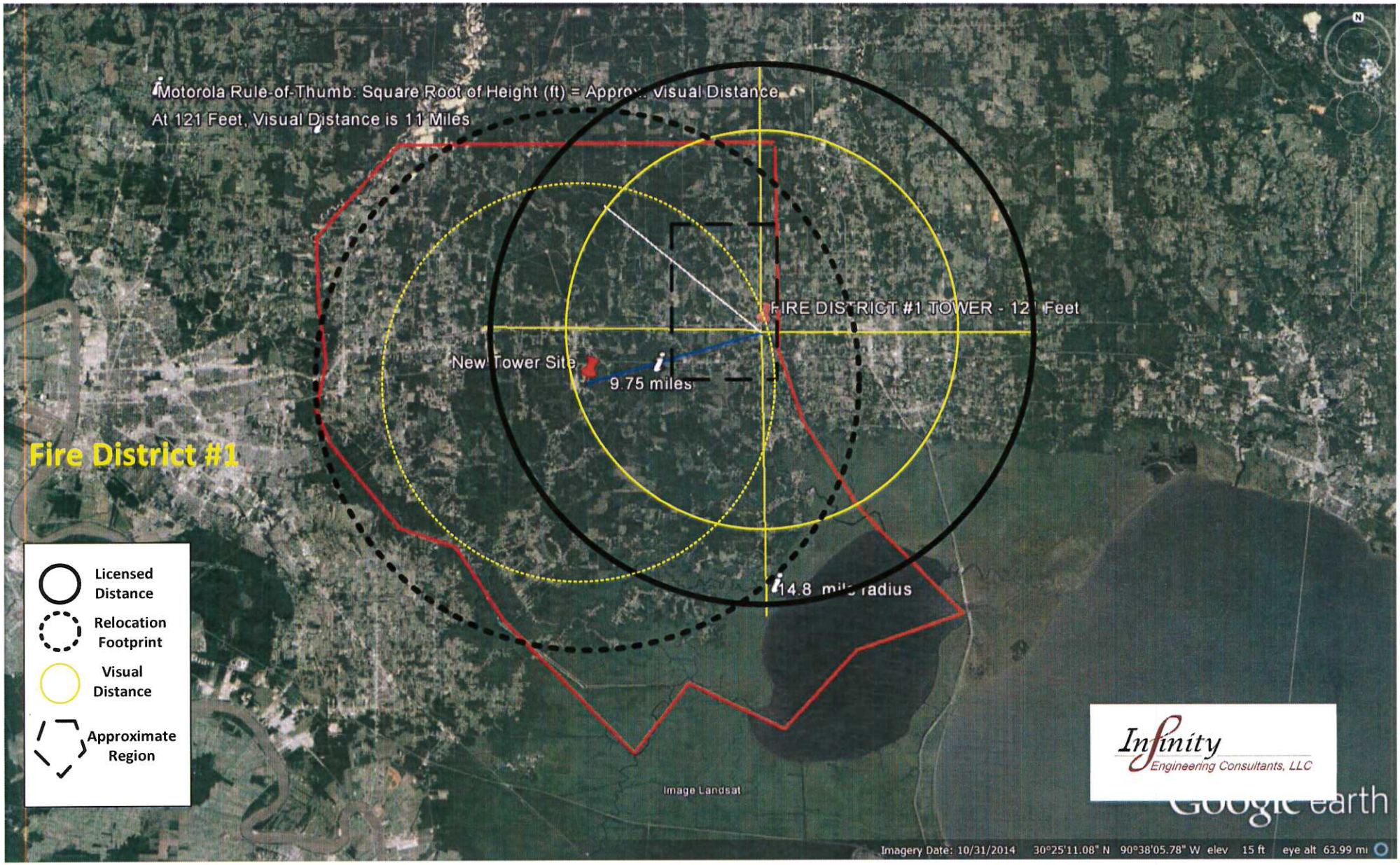
Please provide direction on the proposed tenants of the tower. With confirmed direction, the design team will be putting together an opinion of costs for the construction for the new project.

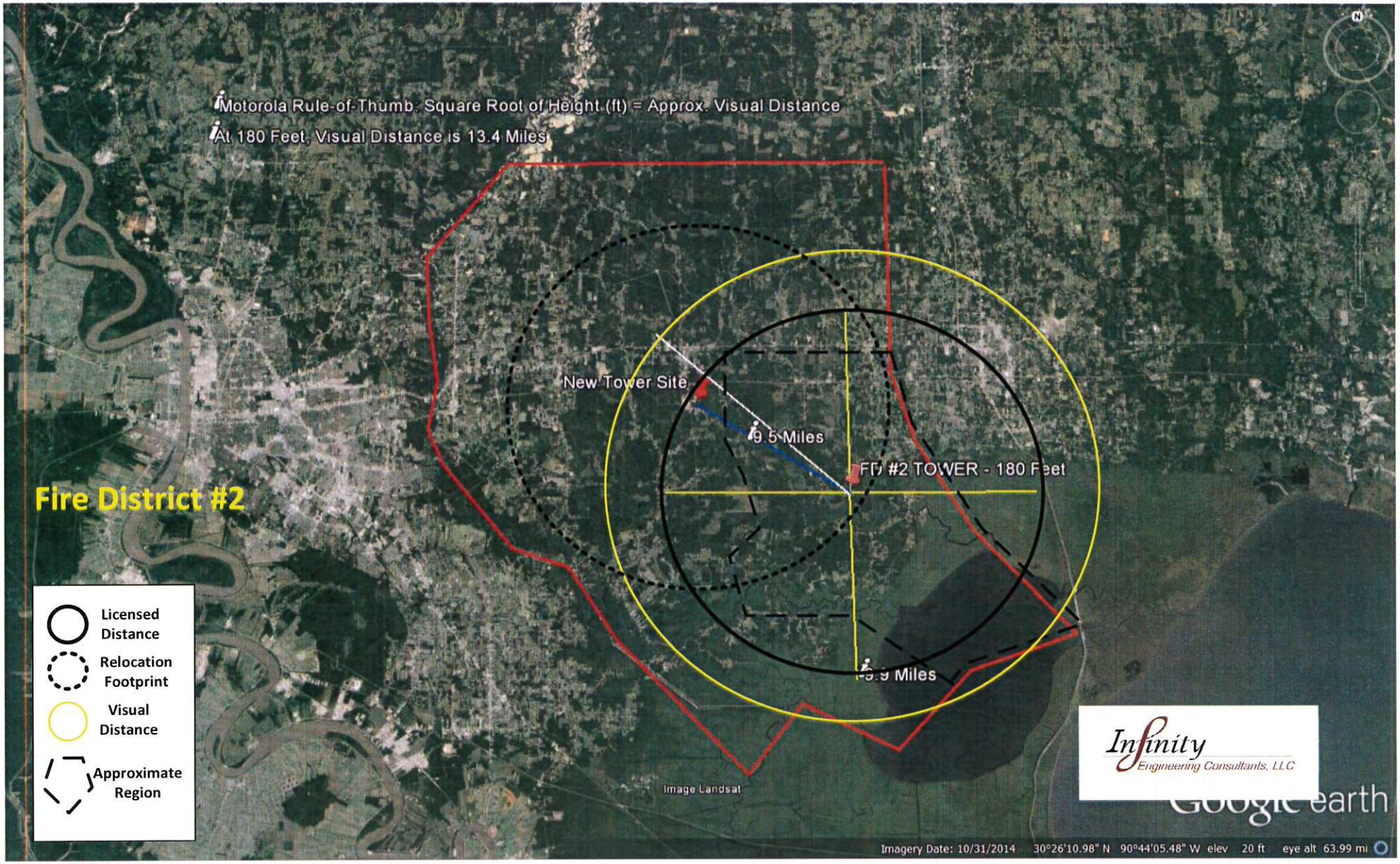
Sincerely,
Infinity Engineering Consultants, LLC

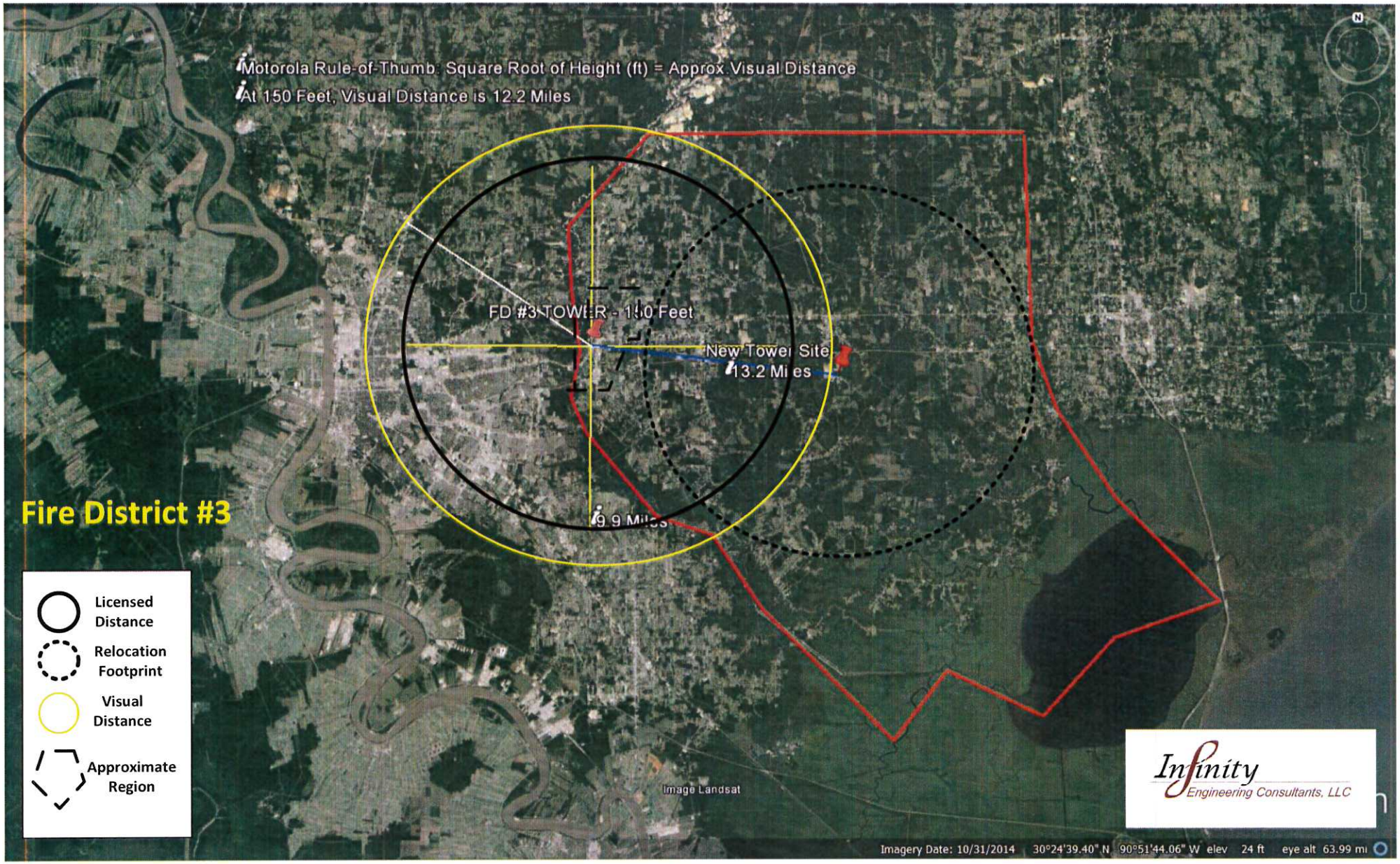
Karson A. Kall P.E.

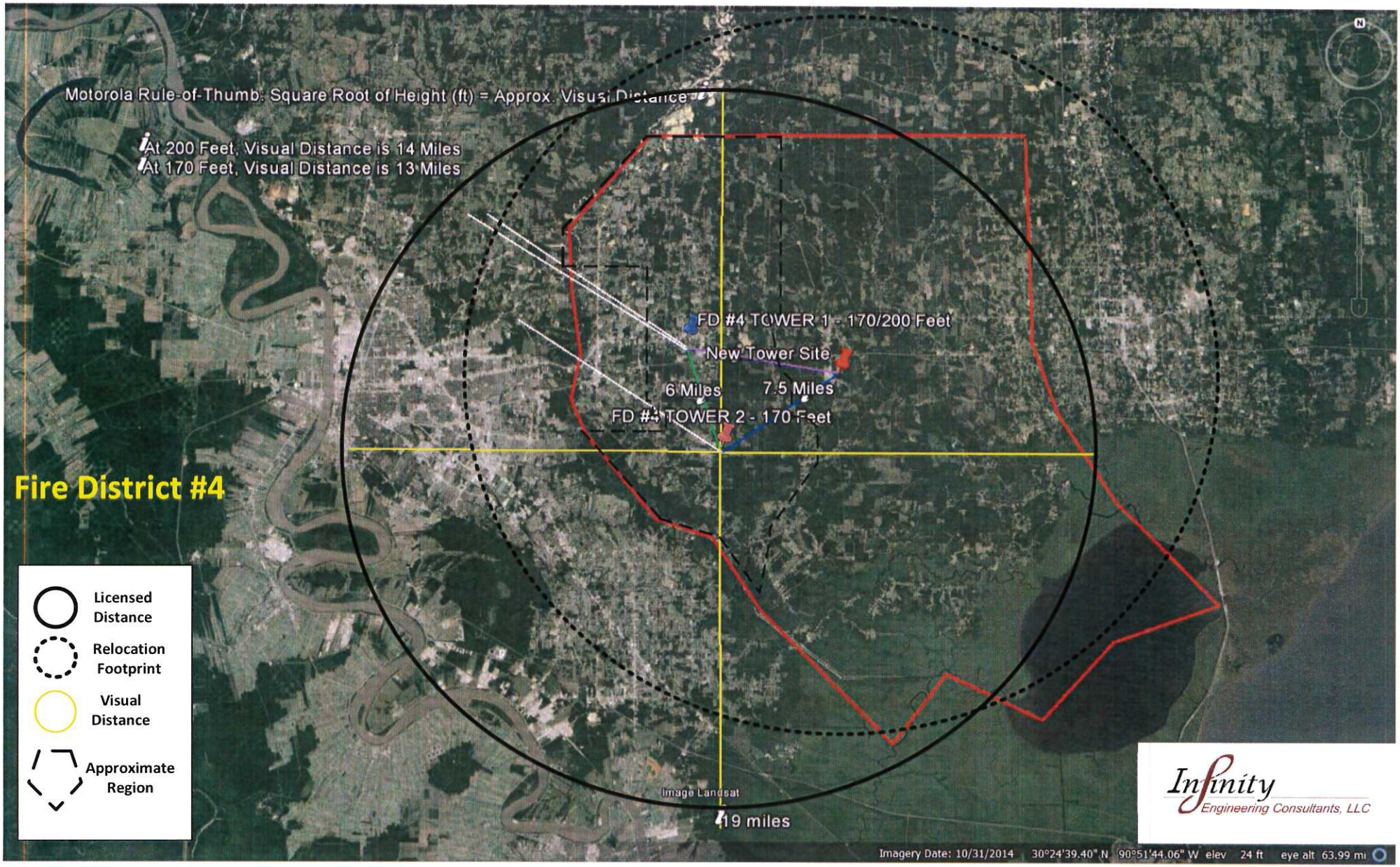
ENCL. Attachment A, B, C & D

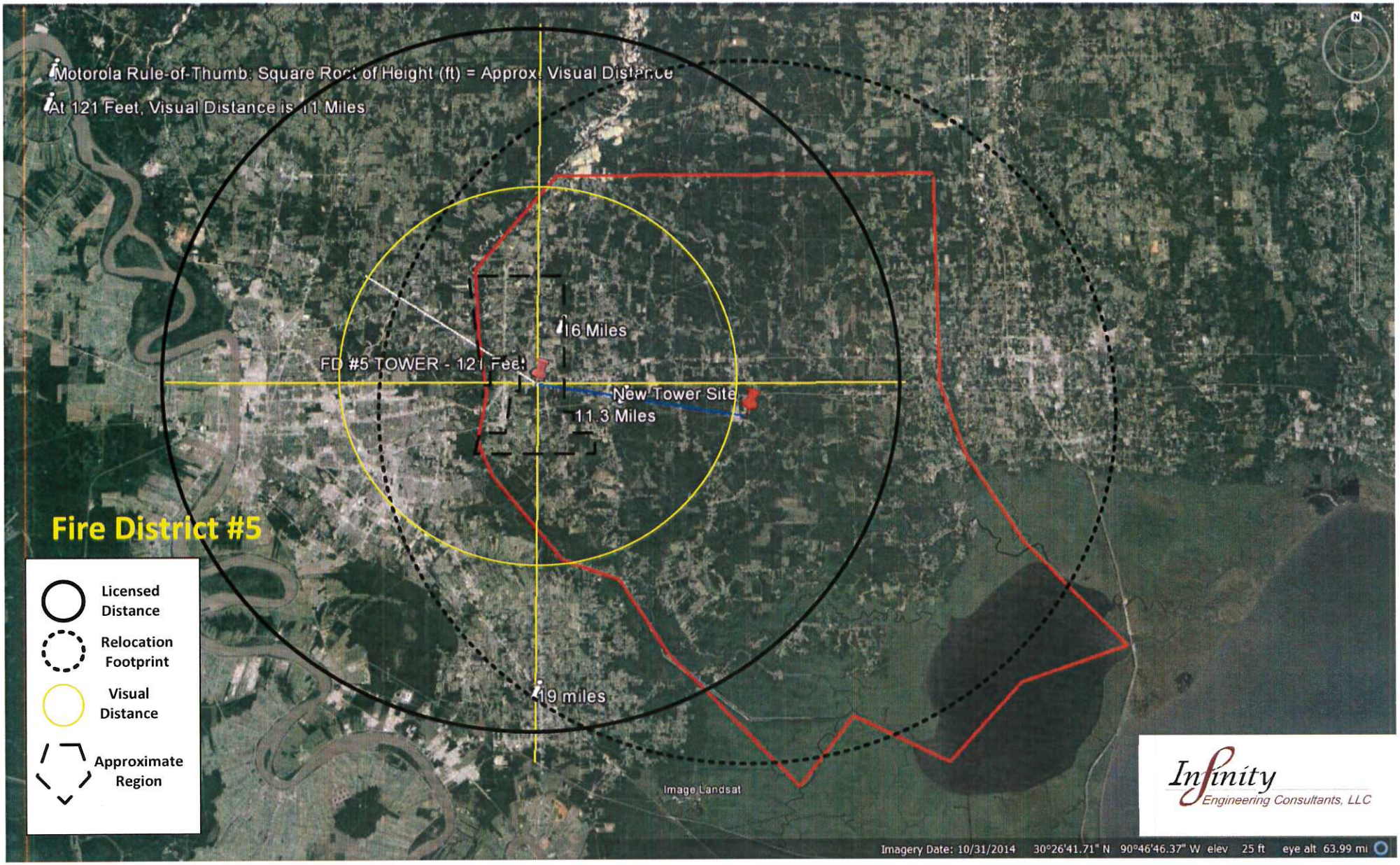
CC: Heather Crane LOHSEP, Michael Chenevert (MML&H) & Tom Henderson (Motorola)

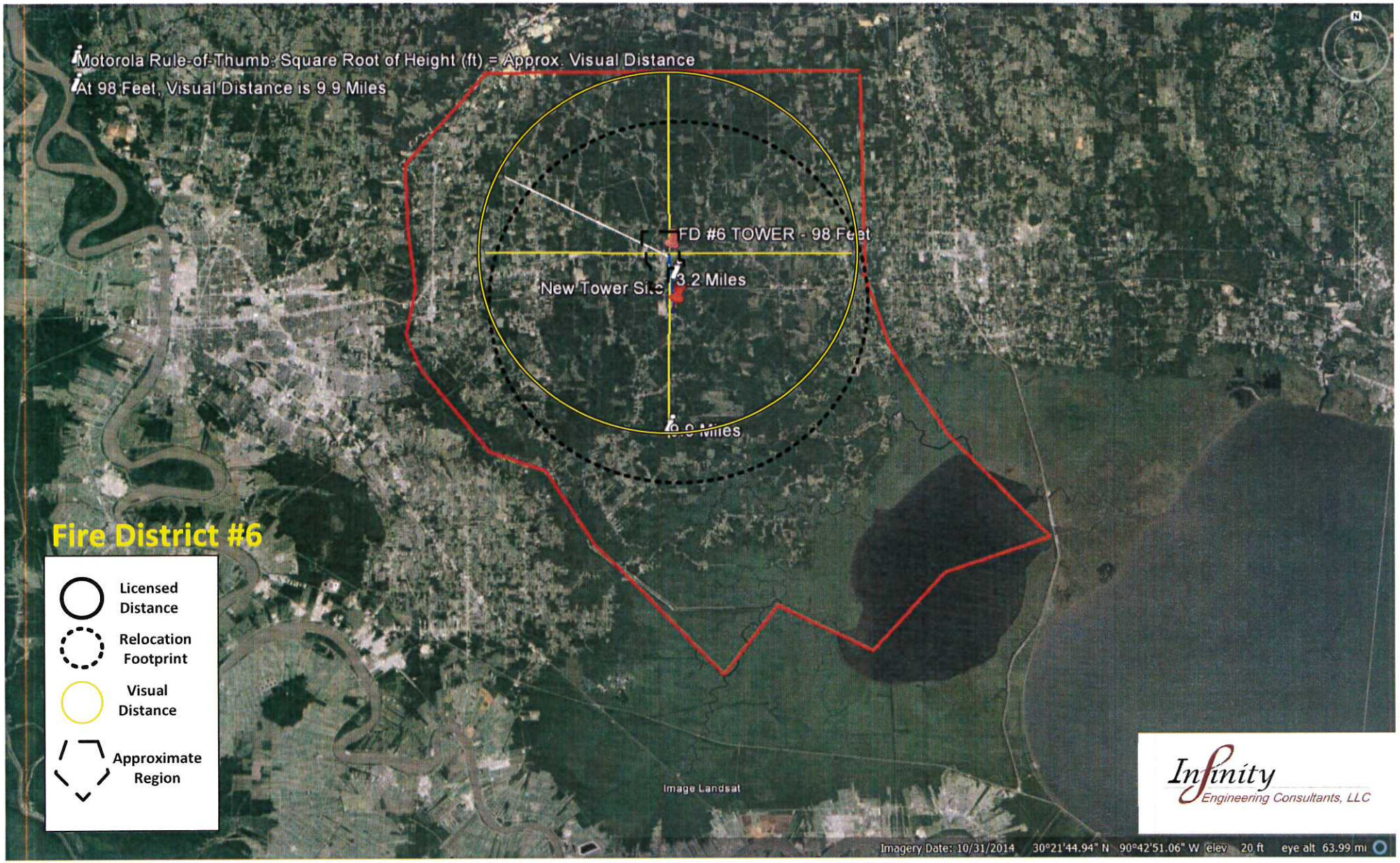

Motorola Rule-of-Thumb: Square Root of Height (ft) = Approx. Visual Distance
At 121 Feet, Visual Distance is 11 Miles
FIRE DISTRICT #1 TOWER - 12 Feet
New Tower Site
9.75 miles
14.8 mi radius
Fire District #1
Licensed Distance
Relocation Footprint
Visual Distance
Approximate Region
Infinity Engineering Consultants, LLC
Image Landsat
Google earth
Imagery Date: 10/31/2014 30°25'11.08" N 90°38'05.78" W elev 15 ft eye alt 63.99 mi

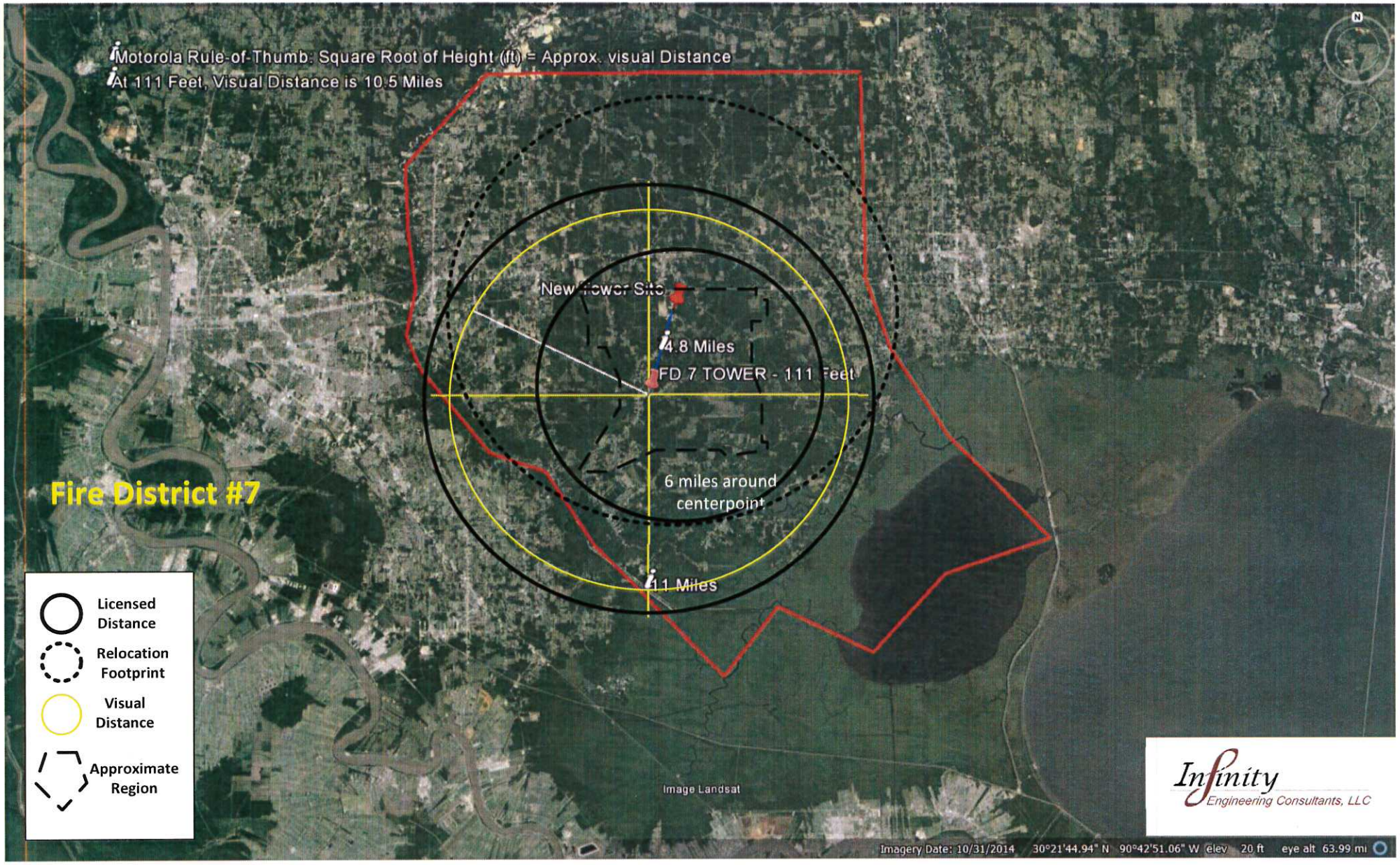

Motorola Rule-of-Thumb. Square Root of Height (ft) = Approx. Visual Distance
At 180 Feet, Visual Distance is 13.4 Miles
New Tower Site
9.5 Miles
FD #2 TOWER - 180 Feet
9.9 Miles
Fire District #2
Licensed Distance
Relocation Footprint
Visual Distance
Approximate Region
Infinity Engineering Consultants, LLC
Image Landsat
Google earth
Imagery Date: 10/31/2014 30°26'10.98" N 90°44'05.48" W elev 20 ft eye alt 63.99 mi

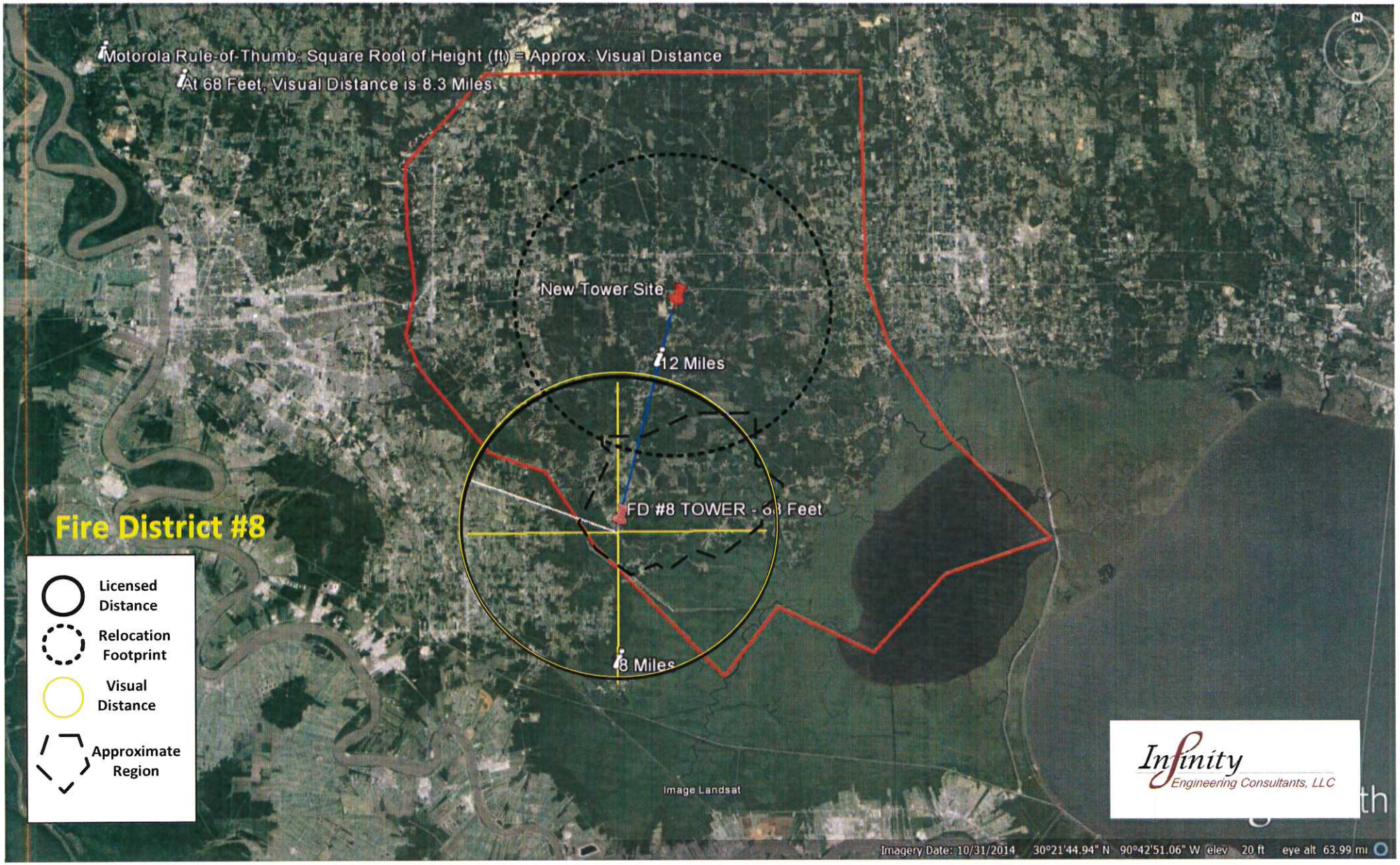

Motorola Rule-of-Thumb: Square Root of Height (ft) = Approx. Visual Distance
At 150 Feet, Visual Distance is 12.2 Miles
FD #3 TOWER - 150 Feet
New Tower Site
13.2 Miles
9.9 Miles
Fire District #3
Licensed Distance
Relocation Footprint
Visual Distance
Approximate Region
Image Landsat
Infinity Engineering Consultants, LLC
Imagery Date: 10/31/2014 30°24'39.40" N 90°51'44.06" W elev 24 ft eye alt 63.99 mi

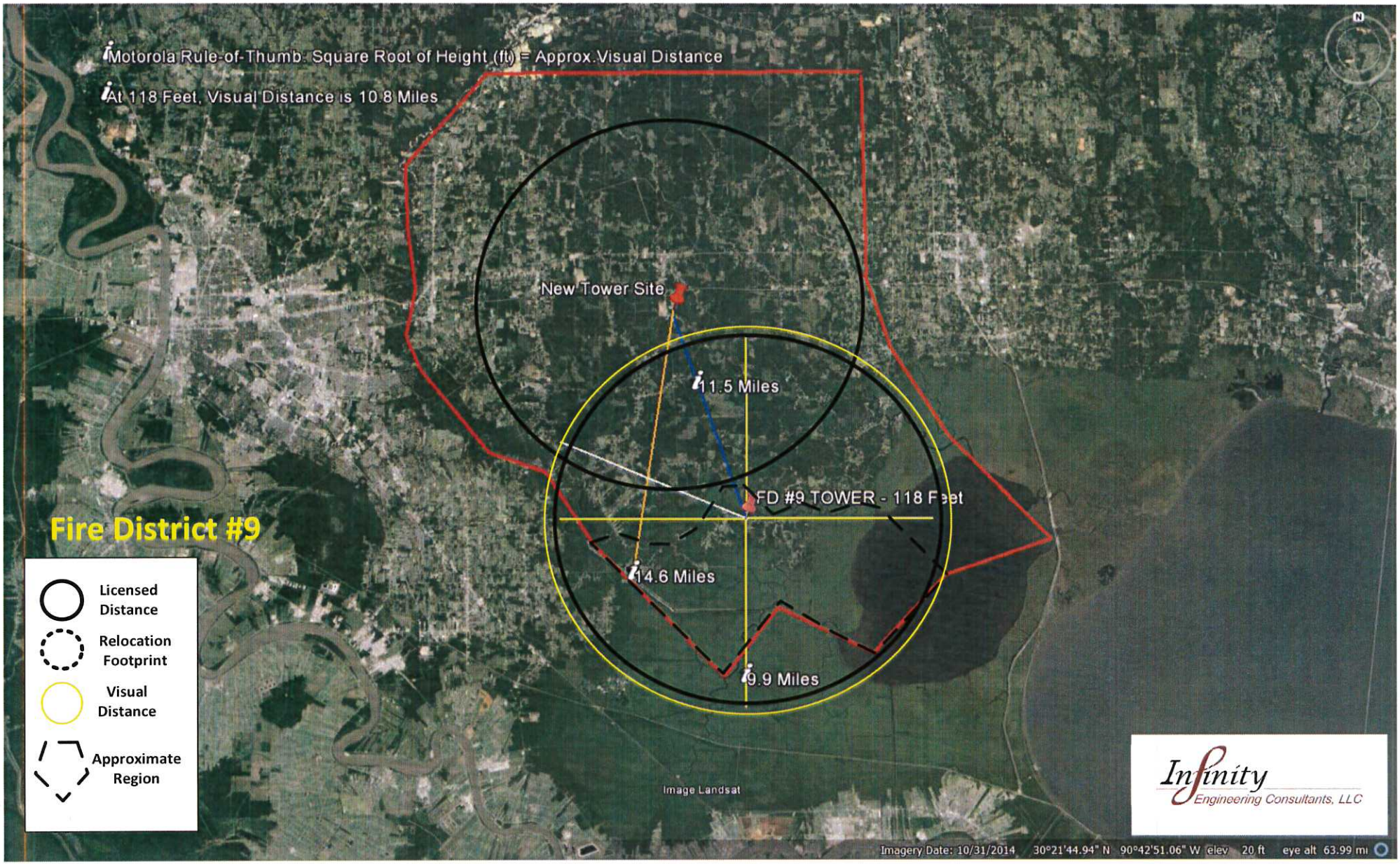

Motorola Rule-of-Thumb: Square Root of Height (ft) = Approx. Visual Distance
At 200 Feet, Visual Distance is 14 Miles
At 170 Feet, Visual Distance is 13 Miles
FD #4 TOWER 1 - 170/200 Feet
New Tower Site
6 Miles
7.5 Miles
FD #4 TOWER 2 - 170 Feet
Fire District #4
Licensed Distance
Relocation Footprint
Visual Distance
Approximate Region
Image Landsat
19 miles
Infinity Engineering Consultants, LLC
Imagery Date: 10/31/2014 30°24'39.40" N 90°51'44.06" W elev 24 ft eye alt 63.99 mi


Motorola Rule-of-Thumb: Square Root of Height (ft) = Approx. Visual Distance
At 121 Feet, Visual Distance is 11 Miles
16 Miles
FD #5 TOWER - 121 Feet
New Tower Site
11.3 Miles
19 miles
Fire District #5
Licensed Distance
Relocation Footprint
Visual Distance
Approximate Region
Image Landsat
Infinity Engineering Consultants, LLC
Imagery Date: 10/31/2014 30°26'41.71" N 90°46'46.37" W elev 25 ft eye alt 63.99 mi


Motorola Rule-of-Thumb: Square Root of Height (ft) = Approx. Visual Distance
At 98 Feet, Visual Distance is 9.9 Miles
FD #6 TOWER - 98 Feet
New Tower Site
3.2 Miles
Fire District #6
Licensed Distance
Relocation Footprint
Visual Distance
Approximate Region
Image Landsat
Infinity Engineering Consultants, LLC
Imagery Date: 10/31/2014 30°21'44.94" N 90°42'51.06" W elev 20 ft eye alt 63.99 mi


Motorola Rule-of-Thumb: Square Root of Height (ft) = Approx. visual Distance
At 111 Feet, Visual Distance is 10.5 Miles
New Tower Site
4.8 Miles
FD 7 TOWER - 111 Feet
6 miles around centerpoint
11 Miles
Fire District #7
Licensed Distance
Relocation Footprint
Visual Distance
Approximate Region
Image Landsat
Infinity Engineering Consultants, LLC
Imagery Date: 10/31/2014 30°21'44.94" N 90°42'51.06" W elev 20 ft eye alt 63.99 mi


Motorola Rule-of-Thumb: Square Root of Height (ft) = Approx. Visual Distance
At 68 Feet, Visual Distance is 8.3 Miles
New Tower Site
12 Miles
FD #8 TOWER - 68 Feet
8 Miles
Fire District #8
Licensed Distance
Relocation Footprint
Visual Distance
Approximate Region
Image Landsat
Infinity Engineering Consultants, LLC
Imagery Date: 10/31/2014 30°21'44.94" N 90°42'51.06" W elev 20 ft eye alt 63.99 mi


Motorola Rule-of-Thumb: Square Root of Height (ft) = Approx.Visual Distance
At 118 Feet, Visual Distance is 10.8 Miles
New Tower Site
11.5 Miles
FD #9 TOWER - 118 Feet
14.6 Miles
9.9 Miles
Fire District #9
Licensed Distance
Relocation Footprint
Visual Distance
Approximate Region
Image Landsat
Infinity Engineering Consultants, LLC
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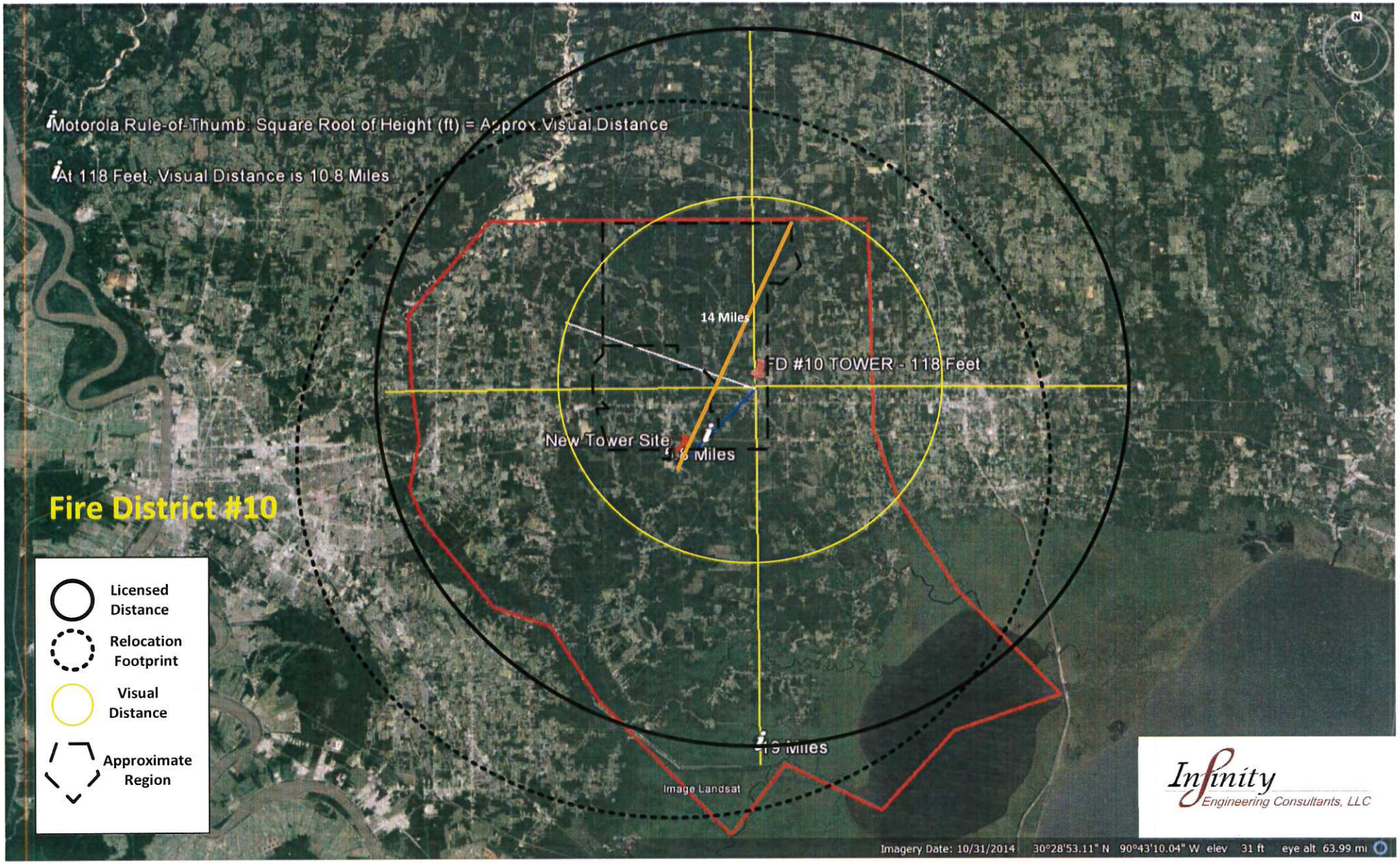
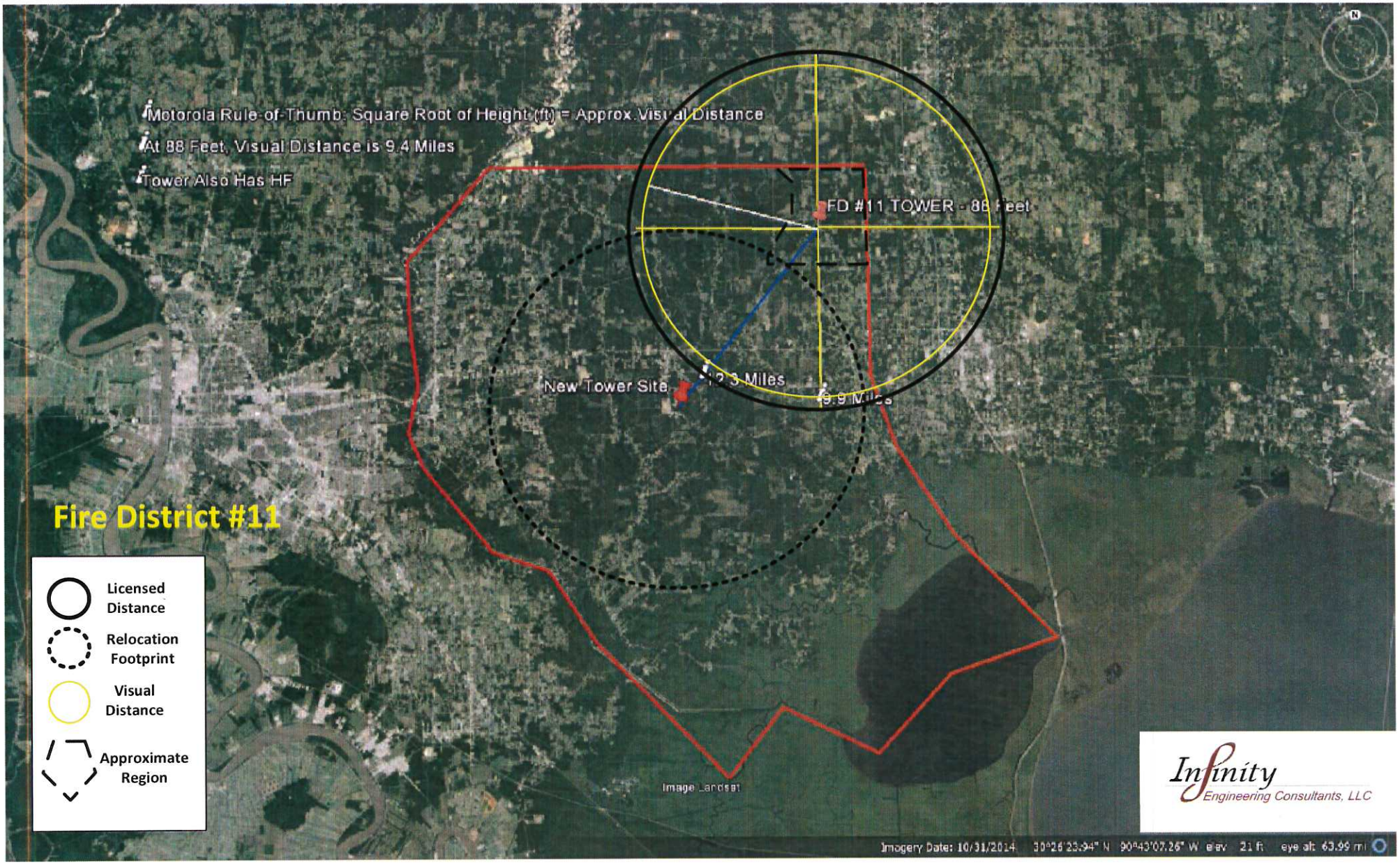
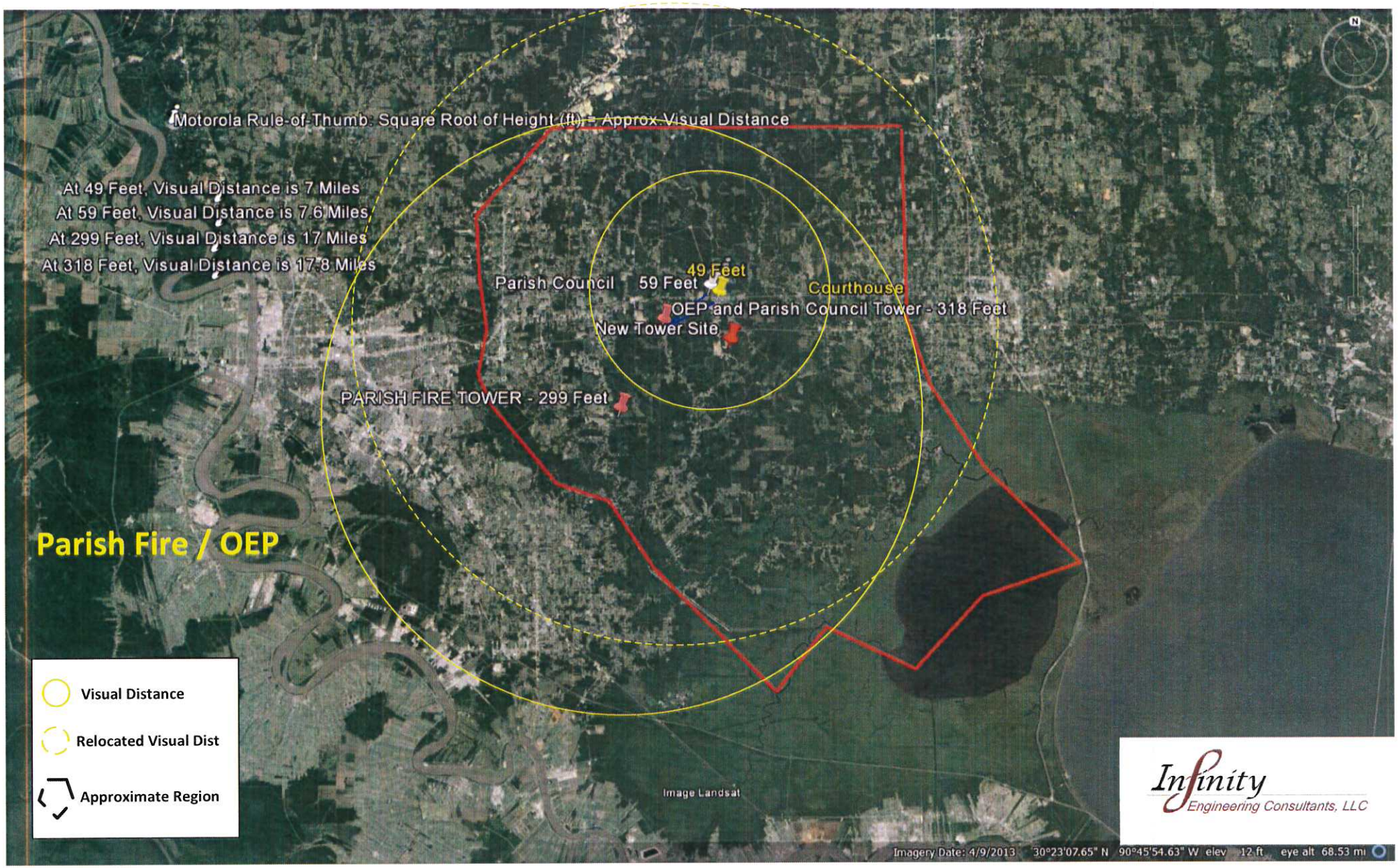
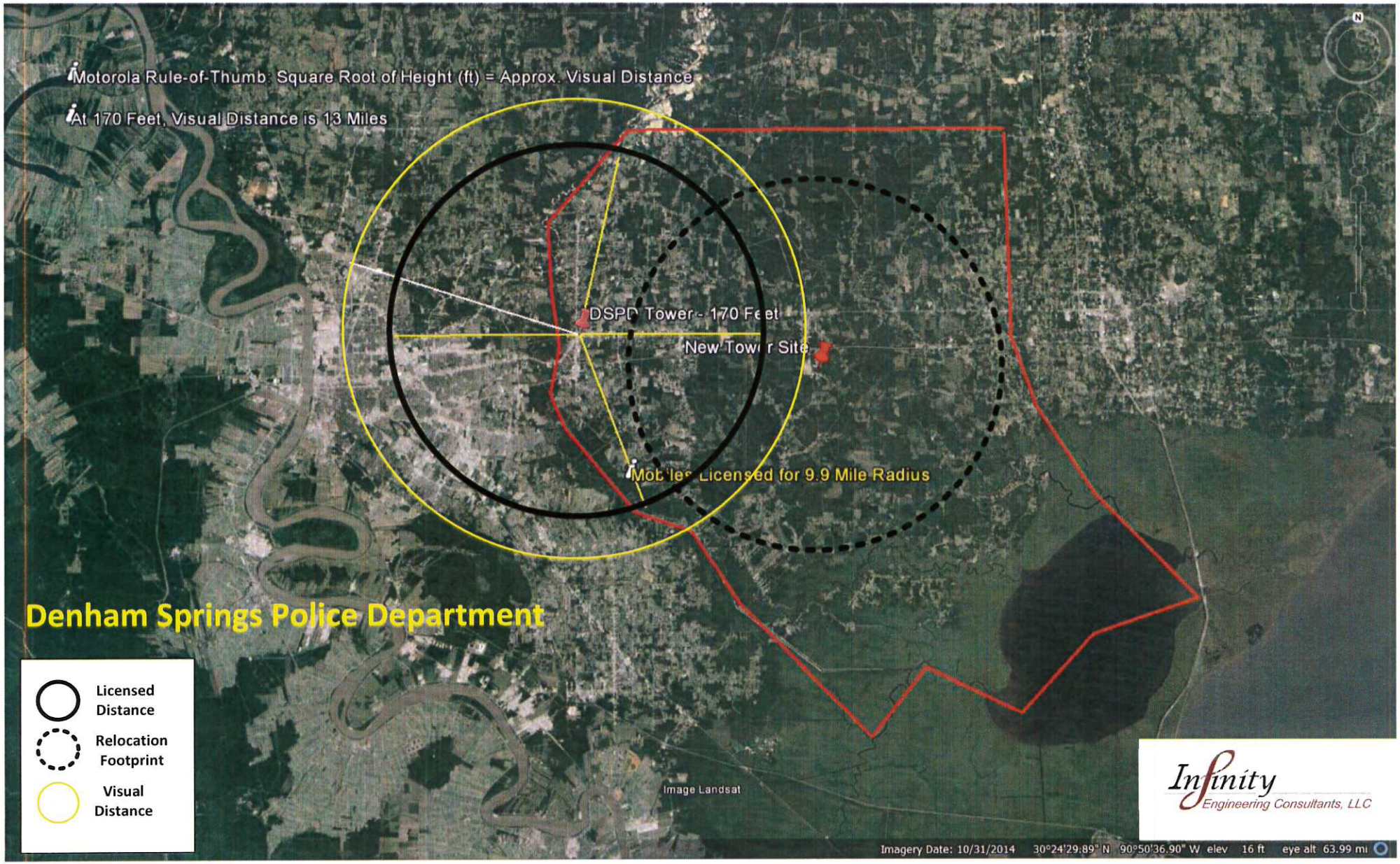
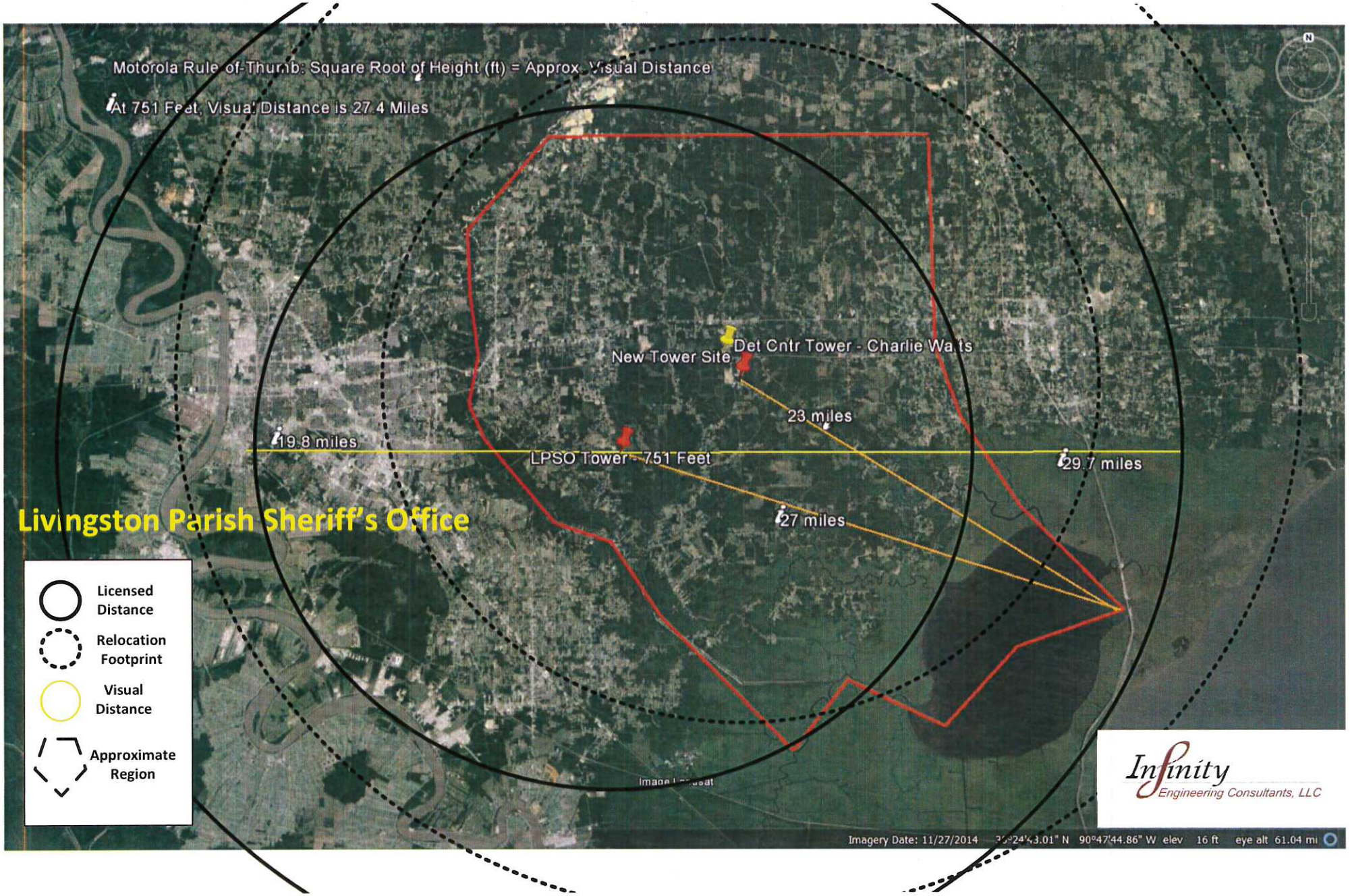
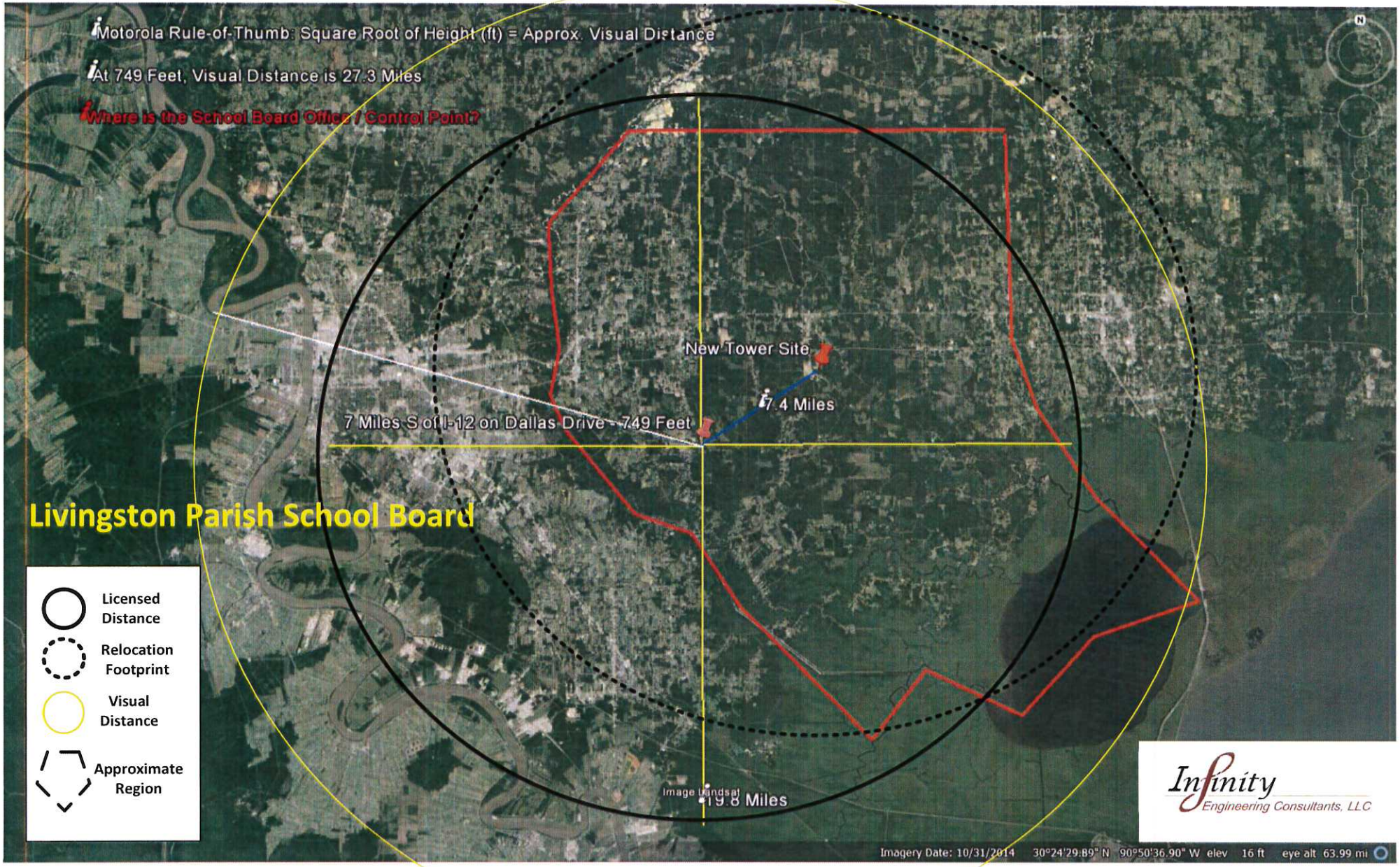

Motorola Rule-of-Thumb: Square Root of Height (ft) = Approx. Visual Distance
At 118 Feet, Visual Distance is 10.8 Miles
14 Miles
FD #10 TOWER - 118 Feet
New Tower Site
Miles
Fire District #10
Licensed Distance
Relocation Footprint
Visual Distance
Approximate Region
Image Landsat
Infinity
Engineering Consultants, LLC
Imagery Date: 10/31/2014 30°28'53.11" N 90°43'10.04" W elev 31 ft eye alt 63.99 mi


Motorola Rule-of-Thumb: Square Root of Height (ft) = Approx. Visual Distance
At 88 Feet, Visual Distance is 9.4 Miles
Tower Also Has HF
FD #11 TOWER - 88 Feet
New Tower Site
2.3 Miles
9.9 Miles
Fire District #11
Licensed Distance
Relocation Footprint
Visual Distance
Approximate Region
Image Landsat
Infinity Engineering Consultants, LLC
Imagery Date: 10/31/2014


Motorola Rule-of-Thumb: Square Root of Height (ft) = Approx. Visual Distance
At 49 Feet, Visual Distance is 7 Miles
At 59 Feet, Visual Distance is 7.6 Miles
At 299 Feet, Visual Distance is 17 Miles
At 318 Feet, Visual Distance is 17.8 Miles
49 Feet
Parish Council
59 Feet
Courthouse
OEP and Parish Council Tower - 318 Feet
New Tower Site
PARISH FIRE TOWER - 299 Feet
Parish Fire / OEP
Visual Distance
Relocated Visual Dist
Approximate Region
Image Landsat
Infinity
Engineering Consultants, LLC
Imagery Date: 4/9/2013 30°23'07.65" N 90°45'54.63" W elev 12 ft eye alt 68.53 mi


Motorola Rule-of-Thumb: Square Root of Height (ft) = Approx. Visual Distance
At 170 Feet, Visual Distance is 13 Miles
DSPD Tower - 170 Feet
New Tower Site
Mobiles Licensed for 9.9 Mile Radius
Denham Springs Police Department
Licensed Distance
Relocation Footprint
Visual Distance
Image Landsat
Infinity Engineering Consultants, LLC
Imagery Date: 10/31/2014 30°24'29.89" N 90°50'36.90" W elev 16 ft eye alt 63.99 mi


Motorola Rule of Thumb: Square Root of Height (ft) = Approx. Visual Distance
At 751 Feet, Visual Distance is 27.4 Miles
New Tower Site
Det Cntr Tower - Charlie Watts
23 miles
19.8 miles
LPSO Tower - 751 Feet
29.7 miles
27 miles
Livingston Parish Sheriff's Office
Licensed Distance
Relocation Footprint
Visual Distance
Approximate Region
Infinity
Engineering Consultants, LLC
Imagery Date: 11/27/2014
90°47'44.86" W elev 16 ft eye alt 61.04 mi


Motorola Rule-of-Thumb: Square Root of Height (ft) = Approx. Visual Distance
At 749 Feet, Visual Distance is 27.3 Miles
Where is the School Board Office / Control Point?
New Tower Site
7.4 Miles
7 Miles S of I-12 on Dallas Drive - 749 Feet
Livingston Parish School Board
Licensed Distance
Relocation Footprint
Visual Distance
Approximate Region
19.8 Miles
Infinity
Engineering Consultants, LLC
Imagery Date: 10/31/2014 30°24'29.89" N 90°50'36.90" W elev 16 ft eye alt 63.99 mi